U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 73.

Experiment Station Work–IV.

PURE WATER.
LOSS OF SOIL FERTILITY.
AVAILABILITY OF FERTILIZERS.
SEED SELECTION.
JERUSALEM ARTICHOKES.
KAFIR CORN.
THINNING FRUIT.
USE OF LOW-GRADE APPLES.
COOKING VEGETABLES.
CONDIMENTAL FEEDING STUFFS.
STEER AND HEIFER BEEF.
SWELLS IN CANNED VEGETABLES.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., March 15, 1898.

SIR: The fourth number of Experiment Station Work, prepared under my direction, is transmitted herewith with the recommendation that it be published as a Farmers' Bulletin.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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EXPERIMENT STATION WORK—IV.[1]

PURE WATER ON THE FARM.

"To those who value their health and that of their family, to those who would have strong and thrifty animals, to those who desire pure milk and first-class butter, we would say that it is of primary importance that the water supply should be from a source beyond suspicion, and that this source should be carefully guarded against pollution." This statement, quoted from a report of the Canada Experimental Farms, calls attention to a subject the importance of which is not fully appreciated on many farms. The experiment stations have made thousands of examinations of samples of drinking water, and these have shown that a very large proportion of the water used on farms, especially well water, is polluted and unfit for use.

In the majority of instances the pollution, as shown by the chemical data, is derived from the drainage of the farm buildings and barnyard, and is consequent upon two causes—the location of the well and the dirty condition of its surroundings. When that most pernicious practice of sinking the well in the stable or barnyard is followed, provision is really being made to collect, as in a cesspool, liquid manure. The amount of manure, the rainfall, and the porosity of the soil are the chief factors that will determine the [rapidity and extent] of the contamination of such wells; it is only in very exceptional cases that they can escape pollution. Let those about to sink wells, therefore, remember that they should not be dug in or near the barnyard nor under the farm buildings. Not a little of this rural well-water pollution is due to the filthy state of the buildings and yard. * * *

The well being sunk at a safe distance from possible sources of pollution, the brick and stone work should be coated to the ground water line with a cement impervious to water. This will protect the well from infiltration of drainage from the upper layer of the soil. Further, a tight-fitting top should be provided, rising to the height of 9 inches or 1 foot above the surface of the surrounding ground.

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[1]This is the fourth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

This will prevent surface water, mice, rats, and frogs from entering. The household slops, garbage, etc., should never be thrown on the soil in the neighborhood of the well; their proper place is the compost heap. Finally, the well should never be used as a cold-storage receptacle, nor the dairy or other vessels washed at the well unless there is an ample provision by a well-constructed drain to take away the wash water.

A well in which water rises suddenly after a heavy rain should be regarded with suspicion unless the surroundings are scrupulously clean; for, as Professor King states, "a sudden large rise and fall of the water level in a well, associated with heavy rains, can have no other interpretation than that water reaches the well without being filtered through a very large amount of soil. An abrupt rise and fall of a few inches might have no significance, but where there is a rise and fall of a foot or more there can be no doubt but the well is liable to yield, at times, unsanitary water if the surface surroundings are such as to permit of it."

It is not the farmer alone who is interested in a pure water supply on the farm.

The health of the large communities of people who draw their food supply from the country is in a measure dependent on the health of the farming community. There is scarcely a city child who is not, in a degree, dependent for its health on the sanitary conditions prevailing in the house of the dairyman. Milk has been repeatedly shown to be the means of distributing typhoid fever and other diseases. Any vegetable foods from the farm eaten raw are liable to become carriers of infection under unsanitary conditions.[1]

A farmers' bulletin of this Department fully and clearly explains the sources of contamination of wells and the means of protecting them from pollution.

LOSS OF SOIL FERTILITY IN DRAINAGE WATER.

Among the principal causes of loss of soil fertility are (1) the growth and removal of crops without restoring the equivalent of the fertilizing constituents they contain, (2) surface washing, and (3) leaching. All crops contain a considerable amount of fertilizing matter drawn from the soil. It is evident, therefore, that if these crops are grown continuously and sold away from the farm without return of an equivalent in manure or fertilizers the soil must in time show a decline in fertility.

The harmful effects of surface washing is a matter of common observation and needs no further discussion here. The loss of fertility in the drainage water, however, is a subject not so well understood. The loss from this cause is generally supposed to be very considerable, and under certain circumstances this is true, depending upon the character of the soil and the treatment to which it is subjected and the fertilizers applied. "Leachy" soils part very quickly with the fertilizing materials applied to them unless covered with crops which utilize the fertilizers promptly.

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[1] U. S. Dept. Agr., Farmers' Bul. 43.

Certain fertilizers also have a tendency to set some of the soil constituents free and thus throw them into the drainage water. As the Massachusetts Station has shown,[1] this is especially true of muriate of potash, which converts the insoluble lime compounds of the soil into a very soluble form, which readily passes into the drainage water. The application of lime compounds (gypsum, etc.) and salt is believed to set free the potash and other fertilizing constituents of the soil, thus rendering them more available to plants, but at the same time more likely to be washed out and lost in the drainage water.

While these are all possible sources of loss, it is probably safe to say that under ordinary conditions the chances of loss of appreciable amounts of lime, potash, or phosphoric acid in the drainage water of soils are very small. This conclusion is confirmed by numerous chemical examinations of drainage water which have been made by experiment stations and similar institutions in the United States and elsewhere.

As regards the loss of the important and expensive fertilizing constituent, nitrogen, however, the case is very different. The soil appears to have very little affinity for the forms of this element so extensively used in fertilizers—nitrate of soda and sulphate of ammonia—and if they are not quickly taken up by the crop they are likely to be lost in the drainage water. Moreover, the insoluble nitrogen of the soil (in humus) or that applied in the form of cotton-seed meal, dried fish, etc., which are also largely insoluble when applied, is rapidly converted by the process of nitrification under favorable conditions into nitrates, which are readily available to plants but which pass out in the drainage and are lost if not taken up promptly by the plant.

Experiments have been reported in which the loss of nitrogen in the drainage from a bare soil in the course of a year was over 160 pounds per acre, while the loss from a soil which was kept covered by a crop was almost insignificant, although fully as large amounts of nitrates were formed in the latter case as in the former. This affords a striking illustration of the importance of keeping a leachy soil covered with a crop in order to prevent serious loss of the most expensive element of fertility—nitrogen. Such a practice would protect the soil from both leaching and surface washing—probably the two most serious causes of decline of fertility of soils.

AVAILABILITY OF FERTILIZING MATERIALS.

In judging the value of a fertilizer it is necessary to take into account not only the total amount of phosphoric acid, potash, and nitrogen which it contains, but also the proportion of these constituents which the plant is able to utilize readily. There are many substances which are very rich in one or more of the fertilizing constituents, but which hold these constituents in such insoluble forms that they are of little

[1] U. S. Dept. Agr., Farmers' Bul. 56, p. 15.

immediate benefit to crops. This is especially true of the feldspars, some of which contain a high percentage of potash, and of certain of the mineral phosphates, such as the Canada apatite, which contain a very large percentage of highly insoluble phosphoric acid. It is true that the fertilizing constituents of such substances, being in no danger of loss through the drainage water, gradually become available in the soil and are thus eventually utilized by the plant. A lasting improvement of the soil is thus brought about; but with modern intensive systems of farming, in which large quantities of expensive commercial fertilizers are bought and used, the farmer very properly fertilizes for the plant and not for the soil, so long as the latter is not injured by the process; i. e., he demands an immediate return in increased crop for the money expended in fertilizers. For this reason he rightly deems it wise and economical to use available fertilizers which act vigorously upon the first crop, rather than those which very slowly become available in the soil, to be gradually withdrawn by succeeding crops To meet this demand the fertilizer dealers supply potash in the readily soluble Stassfurt salts, phosphoric acid in the form of dissolved South Carolina or Florida phosphate, boneblack, etc., and nitrogen in the soluble salts—nitrate of soda and sulphate of ammonia. These are standard articles, and there is no question as to their ready availability. There are, however, many other materials of lower grade which, under certain circumstances, may be used with advantage for fertilizing purposes, and in choosing from these it is of the greatest importance, as stated in the beginning, to know not only their total content of fertilizing constituents, but also the relative availability of the constituents. The natural method of arriving at this information is, of course, to submit the question to the plant in the field by means of fertilizer experiments, and this has been done time and again; but the method is time-consuming, and, even under most favorable conditions, often gives uncertain results.

For this reason students of the subject have endeavored to find some quicker and surer means of comparing the availability of fertilizer materials. Two principal methods have been employed (often in conjunction) for this purpose: (1) Comparison of the fertilizing materials on crops grown in small pots or boxes of specially prepared soil under well-defined or controlled conditions of moisture, temperature, etc.; and (2) determination of the solubility of the different materials in certain chemical reagents. In the latter method the effort has been to find some chemical reagent which dissolves approximately the same amounts of the fertilizing constituents as the crop would actually utilize. As a result of such investigations, we now have a fairly satisfactory chemical method of measuring the availability of phosphoric acid in fertilizers.

The " available phosphoric acid " commonly reported in all analyses of commercial fertilizers is determined by this method, it being simply

the sum of the phosphoric acid soluble in water and that dissolved by a solution of ammonium citrate of a prescribed strength under definite conditions of temperature, time of treatment, etc. Numerous experiments on crops growing in pots and in the field indicate a fairly close agreement as regards phosphoric acid in the majority of cases between the results of the chemical method and those furnished by the plant.

The question of availability does not arise in connection with the potash of fertilizers, because practically all of the potash salts used in fertilizers are soluble in water and probably equally available. As regards nitrogen, however, this question assumes the greatest importance, because this is the most expensive constituent of fertilizers and the one most easily lost from the soil (see p. 5), and because the greatest variety of substances are used as sources of nitrogen in fertilizers.

Several of the experiment stations have undertaken investigations of this subject, and the results obtained are of great practical importance.

In three-year experiments with chemical reagents and with plants growing in pots, the Connecticut State Station found the order of availability of nitrogen in certain of the more important nitrogenous fertilizers to be—(1) nitrate of soda, (2) castor pomace, (3) cotton-seed meal, (4) linseed meal, (5) dried fish, (6) dried blood, (7) horn and hoof, (8) dissolved leather, (9) tankage, (10) steamed leather, (11) roasted leather, and (12) raw leather. These results, which are generally borne out by similar experiments at the Massachusetts Station, show that, notwithstanding the fact that raw leather, for instance, contains a very high percentage of nitrogen, this nitrogen is very slowly available to the plant. When, however, the leather was treated with acid the availability of the nitrogen jumped from twelfth to eighth place. A wide variation in the availability of the nitrogen of the other materials is also shown. While the figures should not be taken as absolutely fixing the relative fertilizing value of the materials, it will be useful to bear them in mind in selecting nitrogenous fertilizers. They may also be helpful in preparing mixtures which will furnish a continuous supply of available nitrogen to the crop throughout its growing period, which is an important consideration in many cases.

SEED SELECTION.

The question of seed selection, although often disregarded, has an important bearing, not only upon the immediate crop but frequently upon many subsequent ones. Leaving out of consideration the relative values of home-grown and commercial seed, experience has shown that all seed should be thoroughly examined for its purity and vitality before planting. Weed seeds are often introduced upon the farm through the sowing of impure seed, and poor crops not infrequently result from planting seed that have low vitality. Examples are numerous where through the presence of dead seed, chaff, weed seed,

and the low vitality of what is genuine, the samples are worse than useless. This experience is not confined to any region nor to this country, the reports from the European seed-control stations showing a similar state of affairs there.

The vitality of seed may be influenced by a number of factors, among which are the kind of seed, degree of maturity at time of harvesting, methods of handling, water content, and temperature at which germination takes place. If thoroughly dried, seed will withstand almost any degree of cold, and may for a few minutes be subjected to a dry heat equaling that of boiling water without injury.

Advantage is often taken of the immaturity of seed. When such seed are planted they tend to produce an earlier and more prolific product, but such practice is at the expense of the ultimate vitality of the stock. This has repeatedly been done with tomatoes, but the general vigor of the plant is lessened although the fruits are ripened somewhat earlier than when mature seed were used.

Aside from the effect of immaturity, the age of seed is an important factor in their vitality. Nothing is definitely known regarding the exact time within which our agricultural seeds retain their vitality, but in general vitality decreases with the increased age of the seed. Some seeds, such as those of cucumbers and melons, are thought to increase in value for a few years, so that 3-year-old seed is considered better than 1-year-old. On the other hand, some seed lose their ability to grow so rapidly that they become practically worthless in a short time. As an extreme case lettuce seed are said to lose their vitality within a few weeks in the tropics, and some seeds must not be allowed to dry out at all if they are expected to grow. Experiments conducted annually for ten years with wheat, rye, barley, and oats showed that the barley and oats retained their vitality very well for that time. The wheat fell off nearly one-half, and the rye became practically worthless for seeding purposes. Tests of seed of a number of forage-plants in England showed a depreciation in vitality during two and one-half years amounting to from 11 to 100 per cent. Similar results have been noted in Germany, where samples from twenty lots of forage-plant seeds were tested for eleven successive years. The last year the white clover germinated 22 per cent and the alfalfa 54 per cent. A few others gave from 1 to 4 per cent vitality, but most failed to sprout. With many seeds the color can be taken as an indication of their age, bright plump seed usually being fresh seed, but the arts of sophistication have been so developed that color is not always a safe guide.

The size of seed bears directly upon the crop produced. It also tends to influence the strain for good or evil dependent upon the size of seed selected. Experiments show almost without exception that the largest and heaviest seed tend to produce the largest and most vigorous plants. The lighter seed may germinate, but the seedling is so weak as to succumb to any sudden change in weather conditions. Experiments in

this Department showed the manifest superiority of large heavy seed over the smaller light ones in the case of radishes, amber cane, Kafir corn, barley, oats, sweet peas, winter vetch, and rye. A series of experiments with rye grass seed in Germany showed that the number of seed capable of producing plants increased with the increased weight of the individual seed.

The too-common practice of selling the best clover and grass seed, saving the screenings for the farm, can not be justified in any way. The screenings contain many weed seed that should not under any circumstances be sown, and the pure seed is usually small and inferior, of low vitality, and can not be depended upon to furnish a good stand.

The effect of fertilizers, soil, and climate on the germination of seeds and on the character of the product has been studied to some extent in France. Certain fertilizers were found to exert a retarding influence on the germination of a number of agricultural seeds. Sulphate of ammonia, chlorid and sulphate of potash, nitrate of soda, and ammoniated superphosphates, when in contact with the seed, were found to injuriously affect the germination of seeds in general. The amount of the different chemicals used was in every case considerably in excess of the quantity ordinarily applied to the soil. It is claimed that the character of the soil on which seed wheat is grown will influence the production from that seed. Seed grown on humus soils should, for the best results, be sown on clay soils. Seed from sandy soils do best on clay or lime soils, and seed from clay soils give the best yields when sown on lime soils. How far this principle will be of practical application can not be stated, but when better understood it may prove very important.

The belief in the effect of a change of seed from one locality to another, especially if it involves a transfer from a northern to a southern region, is so well grounded in common experience as to be frequently practiced in many localities where the variety is thought to be deteriorating. That this belief is well founded seems warranted from the results of many experiments. In France a transfer of seed wheat was made, and the product from the northern-grown seed was in every case heavier and better. Limited experiments with corn and cotton at the Alabama Station gave slightly better yields from the more northern-grown seed. Cooperative tests made in Maryland and Vermont and tests at the Missouri and other stations with potatoes gave the best results from the northern seed. In an extended series of experiments reported in West Virginia Station report for 1896, in which northern and southern seed potatoes and hard-wood cuttings were compared, the more northern product almost invariably gave more prompt germination and vigorous growth. Specimens from Maine and New York were compared to the advantage of the former, showing that but comparatively short removals have their influence.

The effect on fruits is well known. Winter fruits of northern regions

become fall varieties when transferred to warmer climates. Russian winter apples are fall sorts in this country. A transfer in the opposite direction results in retarded growth and late ripening.

Comparisons have been made in which eastern and western grown seed from practically the same degree of latitude were tested without any appreciable differences. Whether this transfer from the one region to the other results in more than an infusion of new blood is not to be discussed here, but it may be ultimately found that the variety best adapted to a given region is one that has been developed in that locality by careful selection and propagation.

So far as our present information goes in the choice of seed for a general crop we should select pure seed having a high degree of vitality. They should be large and heavy, and if productiveness and earliness be desired should probably be from a more northern region.

JERUSALEM ARTICHOKES.

The Jerusalem artichoke (*Helianthus tuberosus*) is a yellow-flowered

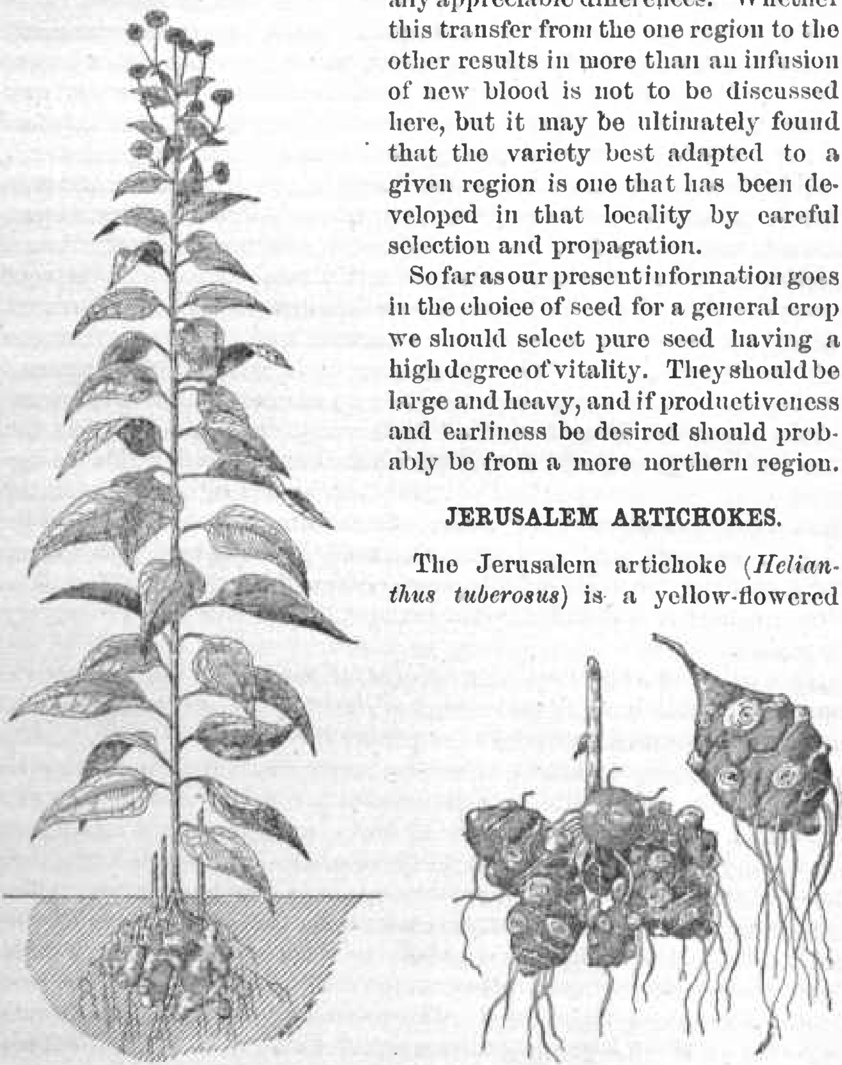

FIG. 1.—Jerusalem artichoke, whole plant and tubers.

perennial plant which reaches a height of 8 to 10 feet and closely resembles the wild sunflower (fig. 1). The term Jerusalem, as applied to this plant, is a corruption of the Italian name for sunflower—*Girasole*—and the name artichoke was applied to it because of the similarity of flavor of the tubers to that of the true artichoke, known as the globe or French

artichoke (*Cynara scolymus*) (fig. 2), which is a thistle-like plant in no way resembling the Jerusalem artichoke. Of the globe artichoke the flower buds are the edible portion, while the Jerusalem artichoke is grown almost exclusively for the underground tubers which it produces. These tubers are as a rule pear shaped and somewhat flattened, resembling potatoes to some extent, but not so smooth (fig. 1). There are white, yellow, red, and purple varieties. The white and red Brazilian varieties have generally given best results. The tubers were formerly used to a considerable extent as a vegetable, especially before potatoes were so extensively grown, but they are now grown in this country principally for stock food, particularly for hogs. In Europe, however, the tubers are eaten as a vegetable, fed to all kinds of stock and used for the manufacture of alcohol. The green leaves and stems have been used to some extent also as a coarse fodder, and the dried stalks for fuel.

FIG. 2.—French (true) artichoke.

The plant will grow on almost any well-drained soil. It will thrive and produce abundantly on light sandy or gravelly soils too poor for many other crops. The main requirement seems to be a dry soil. If the soil is wet the tubers rot. It is drought resistant and, as a rule, remarkably free from fungus diseases and insect pests, although there are a number of diseases which have been known to attack it, and in some cases to do serious injury.

The plant is propagated, like the potato, by means of tubers (the plant generally fails to produce seed), which can be had of any prominent seedsman. The plant requires more space than the potato. The Arkansas Station obtained the best results by planting in hills 3 feet apart each way. It is considered best to plant whole tubers (two or three in each hill, if small), but cuttings with two eyes may be used. Planting should be done as early in the spring as the ground will permit. It may be done in the fall or even in winter if conditions allow. The Jerusalem artichoke is not so sensitive to frost as the potato, and may be planted much earlier than the latter and should be planted a little shallower. The cultivation may be the same as that given potatoes, although an occasional stirring of the surface soil is all that is absolutely required, and frequently good crops are obtained with

little or no cultivation. Pinching off the tops to prevent flowering tends to increase the yield of tubers. The crop matures in about five months.

The tubers may be harvested by plowing them out and picking them up just as potatoes are usually harvested; or, if grown simply for hog feed, they may be left in the ground and the hogs allowed to root them out. Any tubers remaining over winter under the soil will, as a rule, grow the next spring. By this means the soil may be kept stocked, but it is usually advisable to replant each spring (or at least every two years), in order that the plants may be kept in rows and thus more easily cultivated.

The tubers may be left in the ground over winter without fear of injury, provided the soil is well drained, or they may be preserved in a root cellar or stored in pits in the field. When allowed to freeze out of the ground they spoil very rapidly, and when exposed to the air they turn black. When stored in cellars they should be lightly covered with earth, to shut out light and air and to prevent drying.

The yield is usually greater than that of potatoes. A yield of over 600 bushels per acre was obtained at the Arkansas Station on upland soil, and a yield of about 500 bushels on similar soil has been reported by the Idaho Station. At the Massachusetts Station a yield of about 275 bushels was obtained. Yields of 1,000 bushels or more have been frequently reported.

Artichoke tubers resemble potatoes in composition as well as in appearance, but differ from them in containing little or no starch, the latter being replaced principally by a substance similar to starch, known as inulin.

The following table, compiled from American and European analyses, shows the composition (food and fertilizing constituents) of the tubers and tops of the Jerusalem artichoke as compared with other farm crops of similar character:

Food and fertilizing constituents of Jerusalem artichokes and other crops.

	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.	Potash.	Phosphoric acid.	Nitrogen.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Jerusalem artichoke tubers	78.7	2.5	0.2	10.7	0.8	1.1	0.48	0.17	0.36
Potato tubers	78.0	2.2	.1	[1] 18.8		.9	.46	.12	.32
Turnips	90.5	1.1	.2	6.2	1.2	.8	.39	.10	.18
Mangel-wurzels	90.9	1.4	.2	5.5	.9	1.1	.38	.09	.19
Sweet potatoes	71.1	1.5	.4	24.7	1.3	1.0	.50	.10	.23
Jerusalem artichoke tops, green	80.0	1.6	.6	11.2	3.4	3.2	.31	.07	.53
Corn fodder, green	79.3	1.8	.5	12.2	5.0	1.2	.33	.15	.41
Jerusalem artichoke leaves, ensiled	77.7	2.3	.5	10.1	6.0	3.4	....	....	....
Corn silage	79.1	1.7	.8	11.0	6.0	1.4	....	....	....

[1] The amount of fiber in potatoes seldom exceeds 1 per cent and is generally somewhat less.

This table indicates that the Jerusalem artichoke tubers have about the same value as potatoes, and are superior to turnips and mangel-

wurzels for feeding purposes. They are richer in protein, but poorer in carbohydrates—starch, sugar, and similar substances—than sweet potatoes. Some trouble is occasionally experienced in inducing hogs to eat the tubers raw, but they soon acquire a taste for them and thrive on them. They are especially recommended for range hogs by the Arkansas Station. A Western farmer states that 1 acre of artichokes will keep 20 to 30 hogs from October to June in fine condition. They have been found an excellent substitute for a large part of the corn generally used in fattening hogs, both as regards growth and health.

The stalks and leaves of the plant are coarse and apparently unpalatable, but they have been fed successfully to cattle, especially when cut before they have become hard. As the table shows, they compare very favorably in chemical composition with green corn fodder. The table also shows that the leaves can be made into a silage which contains about as much nutritive material as corn silage.

The analyses given indicate that the tubers make about the same draft upon the fertility of the soil as potatoes, while the tops take up about as much total plant food from the soil as corn fodder. The ability of the Jerusalem artichoke to produce good yields on very poor soil is partly explained by its long period of growth (five months).

It has been claimed that the Jerusalem artichoke tubers are more nutritious as a human food than potatoes, and are especially suited to invalids; but there seems to be little basis for this claim, although they undoubtedly possess distinct value as human food. They are eaten boiled or steamed until soft and served with cream sauce; in form of pickles; made into soup (cream of artichokes), and in other forms.

As stated above, the plant is easily propagated. It is also difficult to eradicate, and may become troublesome, as a weed, if neglected. Pasturing hogs and other stock on the artichoke field is an effective means of eradication, as is plowing under in the spring, when the plants are about 1 foot high, and following with a hoed crop.

It is not expected that Jerusalem artichokes will generally take a very prominent place in ordinary farm operations in the United States, but as a side crop, which will furnish a large amount of stock food with little care and cultivation on soils too poor for many other crops, it certainly deserves the serious consideration of farmers, especially those raising hogs to any great extent.

KAFIR CORN FOR DRY REGIONS.

Since the publication of the farmers' bulletin of this Department on Kafir corn[1] several of the experiment stations, especially those of Kansas and Oklahoma, have continued their experiments with this plant, and its culture and use have spread among farmers of certain parts of the West. The experience thus gained has thrown additional light on

[1] U. S. Dept. Agr., Farmers' Bul. 37.

the true value of this crop as compared with corn and similar crops, and upon the best methods of growing, handling, and using it.

The results thus far obtained seem to warrant the general conclusion that Kafir corn has no peculiar merits which justify its extended substitution for corn in regions where the latter can be successfully grown. For instance, Indiana Station concludes that "it is not at all probable that Kafir corn can take the place of common corn to any extent in this State." It has the advantage, however, of withstanding drought better and remaining green longer than corn. As a Kansas grower puts it, "Kafir-corn fodder waits for the farmer. The seed gets perfectly ripe early in the fall, and the stalks and leaves stay perfectly green until frost comes. If it rains it is all right, the seed takes no harm; if it is dry it simply stands still—stays green like an evergreen tree. Cut off the seed and it makes no difference. The field is still green when nothing else is green."

As regards the variety to select, results differ. In Kansas the red variety is preferred to the white varieties as a rule, because it has given larger yields and matures earlier than the white. On the other hand, both the white and the black-hulled white gave larger yields than the red variety at the Oklahoma Station.

In experiments at the Oklahoma Station "the yield of Kafir-corn grain was somewhat larger than that of corn grown on the same tract of land and under like conditions in general," but from the results of feeding experiments at the Kansas and Oklahoma stations with hogs and cattle, and from the experience of practical farmers, "it seems clearly proven that the seed does not equal corn weight for weight in feeding value." The best results would probably be obtained by using the Kafir corn in connection with some more concentrated feed, such as the various oil meals—cotton-seed meal, linseed meal, etc.

The stalks and leaves furnish a valuable coarse fodder in regions where corn or other forage is not so successfully grown. In parts of Kansas and Oklahoma it is reported that it has proved a very satisfactory substitute for hay in cattle feeding. For this purpose it is recommended to drill the seed thickly in rows 3 feet apart. "This will reduce the yield of grain, but give smaller stalks, more readily eaten. A fair crop may be obtained in favorable seasons by planting after the wheat crop is removed." Some have reported difficulty in inducing stock to eat the Kafir-corn fodder. By using alfalfa in connection with it both the palatability and feeding value of the forage would be increased.

"When Kafir-corn seed is thrashed it should be handled a little differently from most other grains. * * * The seed is apt to break badly if the machine is handled in the ordinary way, and to avoid this it is usual to take out the entire concave of the thrashing machine and put a smooth board in its place, thus using only the spikes of the cylinder to thrash the grain. Even with this precaution there will be some

seed broken, and sometimes people take out a portion of the spikes in the cylinder in addition to taking out the concave. It injures the seed badly to have it broken if it is to be put on the market for sale. If it is used for feed it does not make so much difference."[1]

"There is great waste in feeding the seed unground to either horses, cattle, or hogs. If grinding is not practicable it is better to feed the unthrashed heads, as mastication is more thoroughly performed."

THINNING FRUIT.

Thinning the fruit of trees that have a tendency to overbear is recommended very generally and practiced very little. Few extended experiments in thinning fruits have been reported by the experiment stations, but where thinning has been followed systematically for a number of years in commercial orchards, it has been found profitable.

The number of fruits produced per tree may be regulated in two general ways: By pruning away a part of the branches to prevent the formation of too much fruit, or by picking off the superfluous fruits soon after they have formed. With such fruits as grapes, raspberries, blackberries, and the like, the former method is employed almost exclusively. An experiment reported from New York Cornell Station indicates that in the case of blackberries and raspberries no means of regulating the number of berries per plant is necessary other than the annual pruning. The fruit of Cuthbert raspberries and Early Cluster blackberries was thinned by removing some of the clusters and clipping off the tips of most of the others. The size of the berries was apparently unaffected by the thinning. The season was very favorable, however, a good crop being produced. In a more unfavorable season, and with varieties more inclined to overbear, the results might have been different. With light pruning the effect of thinning the fruit would probably be greater than with more severe pruning. Pruning is doubtless more easily done and perhaps more effective than thinning the fruit, and it is probably as safe where there is little danger of unexpected reduction of fruit by accident.

In case of currants and gooseberries, which are, as a rule, pruned less severely than grapes, raspberries, and other fruits, thinning might be expected to give more marked results. A single test with currants has been reported from the New Jersey Station. Since, as a rule, only a few berries of any cluster mature and the tips of the stems die before the fruit ripens, it was thought that by removing the tips the remaining berries might be larger and better. The tips of the fruit clusters of alternate bushes of currants were therefore clipped off before the flowers opened. About 15 per cent more berries set per cluster and the separate berries averaged 7 per cent heavier on the thinned bushes than on the others. The clipped clusters were also more attractive,

[1] W. E. Hutchinson, Kansas State Bd. Agr. Quart. Rpt., Mar. 31, 1896, p. 117.

since there were no dead tips left to injure their appearance. This favorable result can not be claimed for thinning, however, since, as was shown, more fruit set on the clipped than on the unclipped clusters. The results may probably be explained by the greater strain from flower production in case of the untreated bushes. Whether clipping the ends of currant clusters would be uniformly beneficial can not be deter-

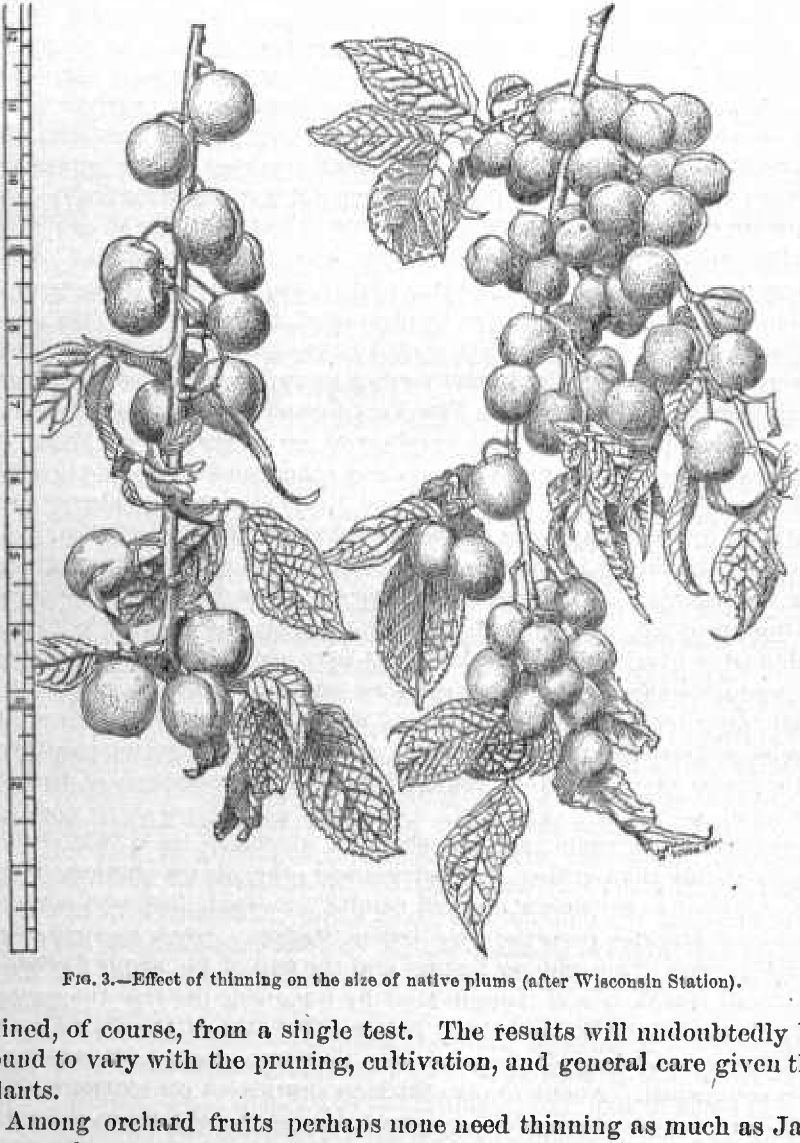

FIG. 3.—Effect of thinning on the size of native plums (after Wisconsin Station).

mined, of course, from a single test. The results will undoubtedly be found to vary with the pruning, cultivation, and general care given the plants.

Among orchard fruits perhaps none need thinning as much as Japanese plums, except possibly peaches which, in commercial orchards, are thinned more systematically than most other fruits. It is reported that in favorable years the fruits of Japanese plums set so thick as to

hide the limbs. In fact, the tendency to overbear is considered by some to be one of their greatest faults. Thinning the fruits of these plums has been favorably reported on by the Alabama College Station. The size of the fruit was increased noticeably by thinning.

The tendency to overbear is also seen in case of some varieties of native plums, as is shown by an experiment with the Gale seedling plum at Wisconsin Station. About four-fifths of the fruit was removed from a portion of a tree, leaving the fruits about 2 inches apart on the branches. The fruits on this portion of the tree were considerably larger than on the unthinned portion, as is shown in the illustration (fig. 3).

The Massachusetts Hatch Station has reported the results of an experiment with apples and plums. A tree each of Gravenstein and Tetofsky apples was thinned on July 1 and a similar tree of each variety left unthinned as a check. In case of the Gravenstein the yield on the thinned and unthinned trees, respectively, was first quality fruit, 9 bushels and 2½ bushels; second quality fruit, 1 bushel and 2½ bushels; windfalls, 9½ bushels and 10½ bushels. In case of the Tetofsky the thinned trees gave 1 bushel of windfalls, and the unthinned tree 3 bushels; of second quality fruit the yield was one-half bushel from each tree; and of first quality fruit the thinned tree yielded 2 bushels and the unthinned tree none at all. Allowing 60 cents per bushel for firsts and 25 cents per bushel for seconds, the market value of the thinned Gravenstein apples was over twice as much as that of the unthinned and of the thinned Tetofsky apples eleven times as much as that of the unthinned. It cost 48 cents to thin the Gravenstein and 35 cents to thin the Tetofsky. The net gain due to thinning was 85 cents for the Tetofsky and $1.85 for the Gravenstein. It is thought that the results would have been more pronounced if the thinning had been done two weeks earlier. The large percentage of windfalls in case of the Tetofsky was believed to be largely due to the fact that the apples have very short stems and are borne in clusters of from three to eight fruits each, so that as they grow they become very much crowded. With trees having this characteristic, therefore, thinning is especially valuable.

The results with plums were similar to those with apples as regards the increased production of fruit. A tree each of Guei and Victoria plums was divided into approximately equal halves, one half being thinned and the other half left as a check. The thinned half of the Guei tree yielded 9 quarts of marketable fruit and the unthinned half 5½ quarts. The yield of marketable fruit from the thinned and unthinned halves of the Victoria tree was 16 quarts and 9½ quarts, respectively. The value of the fruit was taken to be 9 cents per quart, and the cost of thinning 12 cents for the Guei and 18 cents for the Victoria, giving a net gain due to thinning of 20 cents and 41 cents, respectively.

Another very marked result obtained from the test with plums was the decrease of brown rot in case of the thinned fruit. On the thinned half of the Guei tree 28 per cent of the fruit was affected with rot, and on the unthinned half 42 per cent; on the thinned half of the Victoria tree 20 per cent, and on the unthinned half 46 per cent.

The New York State Station has recently begun an experiment with several varieties of apples. The first year the thinning was done when the largest apples were about 1½ inches in diameter. One Baldwin tree was thinned by removing all wormy and otherwise inferior fruit and leaving one apple to a cluster, a similar tree left unthinned being used as a check. The unthinned tree yielded 32¼ bushels of marketable fruit, and the thinned tree only 27¾ bushels, or about 14 per cent less than the unthinned tree. The amount of No. 1 fruit, however, was the same (19½ bushels) in each case, and there was only one-third as many culls on the thinned tree as on the other. A test with three Baldwin and three Greening trees was more favorable to thinning. The fruit was thinned, as in the previous case, and the remaining fruit thinned to 4 inches apart. The unthinned Baldwins averaged 26.1 bushels of marketable fruit per tree, and the thinned ones 20.7 bushels. But an average of 16.7 bushels of the thinned fruit, and an average of only 15.4 bushels of the unthinned fruit graded No. 1. In case of the Greenings, an average of 16.7 bushels of marketable fruit per tree was obtained from the thinned trees, and an average of only 15.8 bushels from the unthinned trees. The percentage of No. 1 fruit was also, as in the previous cases, greater with the thinned than with the unthinned fruit, there being an average of 14.7 bushels of the thinned as against an average of 12.4 bushels of the unthinned. Similar results were obtained from a Hubbardston tree which was thinned as in the last case, except that the apples were left fully 6 inches apart. The unthinned tree yielded 26.3 bushels of marketable fruit, and the thinned tree but 21 bushels. Here again a greater quantity of No. 1 fruit was obtained from the thinned than from the unthinned tree, the quantities being 15 bushels and 14.3 bushels, respectively. The report says: "In all these tests the thinned trees gave fewer drops than the trees that were not thinned, and all grades of fruit were higher colored and clearly superior to the same grade of fruit from the unthinned trees." It was estimated that the thinned fruit would bring from 10 to 15 per cent more in the market than the unthinned fruit. The thinning and harvesting together took about twice as much time as the harvesting alone where the fruit was not thinned.

The advantages claimed for thinning orchard fruits are about as follows: Thinning increases the size of fruit, gives it more color, and a better flavor. It diminishes the amount of worthless fruit, windfalls, etc., increases the amount of No. 1 fruit, and in some cases increases the total yield. It lessens the amount of rot, especially in the case of peaches and plums, since the diseases can spread less easily where the fruits do

not touch each other. Thinning also tends to keep injurious insects in check, as care is taken to remove the infested fruit. It is also probable that the production of large quantities of inferior or worthless fruit weakens the vitality of trees so much that it takes considerable time for them to recover. It is also thought that even where the total crop is not much greater on unthinned than on thinned trees the production of a greater number of seeds on the former is an important factor in lowering the vitality of the tree. Trees which are overloaded one year seldom bear much the next, but in cases where thinning has been practiced systematically for several years little trouble has been experienced in this regard. In favorable seasons where large crops can be produced without overtaxing the trees, thinning will doubtless influence the size and appearance of fruit somewhat less than in unfavorable years. On the other hand, favorable years are marked by great production of fruit, overcrowded markets, and very low prices for all but the best fruit. These are the years when any increase in the percentage of first-quality fruit is of the greatest importance. As to whether thinning shall or shall not be done will depend largely on the tendency of the varieties grown to overbear or to set fruit sparingly; on the pruning, cultivation, and general care the trees receive; on the climatic conditions of the locality and of the season; and on various other conditions. The better color of fruit, the lessened injury from rot and the like, are much stronger arguments for thining fruit in the humid climate of the East than they are in the drier, clearer climate of the West, yet it is probable that there are few localities where judicious thinning would not, in certain cases at least, be beneficial.

As to methods of thinning, few absolute statements can be made, so much depends on the conditions under which thinning is to be done. Experiments so far reported give little data upon which to base such statements. There are certain things, however, which must be considered in any case. Thinning should be delayed until there is no further danger of premature dropping of fruit from lack of pollination, the effect of frosts, or other accidental causes. It should be done, however, before the fruit becomes so large as to tax the tree. The usual recommendations are to thin plums when about half grown and before the pits harden; peaches, when the size of small hickory nuts, or when half an inch in diameter; apples, when the size of hickory nuts to 1½ inches in diameter. The amount of fruit removed will depend largely on the previous pruning, and on the age, size, and variety of the tree. The fruits should be left far enough apart so as not to touch each other, and it is often recommended to leave them from 4 to 6 inches apart.

Fruit should be picked by hand, the wormy, diseased, and otherwise inferior fruits being removed. Mechanical devices for thinning are not recommended, since they do not discriminate between good and bad fruits, do not leave fruits well distributed, and often break off or injure the fruit spurs. It has been suggested that, since the same fruit spur

rarely ever produces fruit two years in succession, the fruit should be entirely removed from part of the spurs in order that they may produce fruit buds for the following year. It is thought that if this is followed systematically there is no reason why trees should not bear well every year, instead of every two or three years, as is so often the case.

THE UTILIZATION OF LOW-GRADE APPLES.

The Virginia Station has reported experiments on various means of utilizing low-grade apples which, it is estimated, constitute 40 per cent of the annual crop in that State. Considerable quantities of this fruit are at present sun dried, but it is believed that the use of evaporating apparatus would be much more economical. The cost of manufacture in either case is about 3 cents per pound of finished product. The evaporated fruit as a rule sells for about 6 cents per pound and the dried for only 2½ cents. The amount of evaporated fruit per bushel of apples was found to be about 6.6 pounds. Assuming that the same amount of dried fruit can be obtained per bushel of apples, and estimating the cost of green fruit at 8 cents per bushel, which is considered a reasonable price for the class of fruit used, a net gain of nearly 12 cents per bushel is realized for evaporating apples, and a net loss of 11 cents per bushel for drying them.

At first two small portable furnace evaporators with the necessary machinery for preparing the fruit were tried, but it was found impossible to produce evaporated fruit at a profit with them. Next a steam evaporator was devised, which proved more satisfactory than the portable furnace evaporators, but it was too small to be run profitably. It is thought that a steam evaporator of 100 to 200 trays capacity could be run with good profit. The steam plant should be able to maintain a steam pressure of 100 pounds and the temperature of the evaporator at 250° F. The evaporator should be aided by means of flues extending to a considerable height. The highest heat should be maintained at the top of the evaporator, and the fresh fruit introduced there so that the vapor will be carried off directly into the flues without checking the curing of the partly dried fruit. As the fruit dries it is placed lower down and finishes at the bottom or coolest part of the evaporator. It is thought no evaporator of less than 50 bushels capacity per day can be run economically.

Aside from evaporation, the manufacture of cider and its products is considered the only practical way of disposing of low-grade apples. With the best hand grinders and presses cider making was found very unprofitable. Only 2 gallons of cider were obtained per bushel of apples, while with a medium-sized grinder and press run by an 8-horsepower engine, 4 gallons were obtained per bushel. With green apples at 8 cents per bushel, cider made with hand grinders and presses cost 6 cents per gallon, while with the larger grinder and press it cost only 2.3 cents per gallon.

Jelly, marmalade, and vinegar making were tried with somewhat

incomplete equipment. The results indicated that the manufacture of at least some of these products can be made profitable. For making jelly a steam apparatus was used. With cider at 2.3 cents a gallon pure jelly was produced at a cost for material of about 1 cent per pound of finished product, 100 pounds of cider (11 gallons) making 25 pounds of jelly. A jelly suitable for table use, made by adding 1 pound of sugar to 5 pounds of cider, cost for material about 3 cents per pound of finished product, 40 pounds of jelly being made per 100 pounds of cider.

The manufacture of marmalade with a steam cooker was tried. A better class of apples is required for marmalade than for cider. It was found advantageous, however, to cook the apples in cider rather than in water. With apples at 20 cents per bushel marmalade cost for material less than 2 cents per pound of finished product, an average of 116 pounds being made from 80 pounds of sliced fruit, 8 gallons of fresh cider, and 35 pounds of sugar. It was found more economical to cook the apples without previous paring and coring, the cooked product being run through a colander. In this way the loss was not over 5 per cent of the weight of the fruit, while the loss from paring and coring the apples averaged 25.4 per cent. Furthermore, the operation required considerable time and did not avoid the necessity of putting the fruit through the colander.

For pure cider vinegar no mature apples are considered too poor. Vinegar making in the ordinary way, by allowing the cider to ferment at will in casks without controlling the surrounding conditions, gave results that were far from profitable. By regulating the temperature and adding vinegar mother and cultures of acetic-acid ferment fairly good vinegar was secured, but the process was slow and wasteful. By mixing equal parts of fermented cider and old vinegar the process of fermentation was greatly hastened, but the method can not be followed without a large stock of old vinegar on hand. Very good results were secured by using a vinegar generator in which the cider passed slowly through a mass of shavings, where it was thoroughly aerated and fermentation thus hastened. The generator consisted of a 4 by 8 foot wooden tank filled with beech shavings, provided with holes near the bottom for the admission of air, and fitted 1 foot from the top with a wooden disk perforated to allow the entrance of the cider, which was distributed evenly over it by means of a dumper. The vinegar was drawn from the tank by means of a siphon of glass tubing inserted in a hole near the bottom. The temperature of the fermenting cider in the mass of shavings was controlled by regulating the supply of air, some of the air holes being shut off when the temperature rose too high and opened when it fell too low. In order to acidify the shavings and start the process of fermentation, the generator was charged with strong vinegar, and again with vinegar in which some concentrated grape juice was dissolved. The stock solution, a mixture of weak vinegar and fermented cider, was then run through the generator at the rate of 20 gallons per day (twenty-four hours). The resulting product was a very good vinegar,

ranging from 4.05 to 5.87 per cent acid. A mixture of half vinegar and half fresh cider failed to produce good vinegar without being run through the generator twice. Better results were obtained by allowing the cider to ferment for some time in casks before running it through the generator. The temperature within the generator 2 feet from the bottom ranged from 88° to 106°. The higher temperature caused a loss of alcohol and lowered the acidity of the product. Temperatures below 90° did not give good results. The optimum is thought to be about 95°. It is believed that this method of manufacturing vinegar might be used with considerable profit if it were not for the cheap vinegars made as by-products from various factories and colored and flavored to imitate cider vinegar.

LOSSES IN THE COOKING OF VEGETABLES.

In their natural condition the texture of most vegetables is hard and resistant, and they require some treatment which shall render them fit for food. This treatment is found in the application of heat, usually either by boiling, frying, or baking, the first being the method most commonly used.

Vegetables contain a large amount of water, or, as it is frequently called, "juice." Dissolved in the juice are considerable amounts of soluble inorganic compounds or salts, and more or less soluble organic substances, such as sugar and soluble protein (nitrogenous) compounds.

The solid matter of vegetables consists largely of microscopic cells filled with starch grains. The walls of these cells are composed of cellulose or woody fiber, which resists the action of the digestive juices, so that these can not get to the starch contained within. It is for this reason that the raw vegetable is, as a rule, unfit for food. When, however, heat is applied the starch grains absorb water from the juice, swell up and finally burst the cell walls, so that the texture of the vegetable becomes soft and the nutrients are easily attacked by the digestive juices.

During the process of boiling vegetables there is, of course, more or less opportunity for nutrients soluble in water to be dissolved out and lost. Indeed, much of this matter is already in a state of solution in the juices. The nutrients which would be liable to suffer such loss are, as mentioned above, some of the protein compounds, some of the mineral constituents, such as salts of potassium and sodium, and especially the sugars. The starch would suffer no appreciable loss in this way, owing to its insolubility. It might, however, be removed mechanically from the soft cooked vegetables under certain conditions. Of the protein compounds, those which are of the most value to the body are coagulated before the boiling point is reached, and thus rendered insoluble, behaving like the white of an egg under similar conditions. The loss of the more valuable portion of the protein would therefore take place before the water got sufficiently hot to cause coagulation. Some nitrogenous substances are, however, soluble in water at all

temperatures, and would therefore be liable to loss during the entire process of boiling. Sugar is present in considerable amounts in some vegetables as, for example, beets and carrots. In such cases the loss of nutrients may amount to a considerable fraction of the original nutritive value.

Some interesting experiments have been recently made by the Minnesota Station and at Middletown, Conn., in connection with work on food and nutrition carried on in cooperation with this Department. In these experiments vegetables were boiled under different conditions, and the loss of nutrients determined.

The first series of experiments was made with potatoes, which were taken as representative of the class of vegetables known as tubers, and in fact as the most important tuber in common use. These were boiled under different conditions and the loss determined. When peeled and soaked for several hours before boiling, the loss amounted to 52 per cent of the total nitrogenous matter and 38 per cent of the mineral substance; when the potatoes were peeled and put into cold water, which was then brought to a boiling point as soon as possible, the loss was much less, amounting to about 16 per cent of the nitrogenous matter or protein and to 19 per cent of the mineral matter; potatoes peeled and placed at once in boiling water lost but half as much nitrogenous matter as in the preceding case, although the loss of mineral salts was practically the same; when, however, potatoes were cooked with their skins on, there was but a very trifling loss of matter, either nitrogenous or mineral. The character of the water, i. e., whether "hard" or "soft," had but little influence on the result. In none of the experiments was there any appreciable loss of starch other than that resulting from the abrasion of the peeled potatoes when, during the latter part of the boiling, they had become soft and mealy. At times, however, this loss amounted to nearly 3 per cent of the whole nutritive value of the potato. When boiled with the skins on, it was almost entirely avoided.

In order, therefore, to obtain the highest food value, potatoes should not be peeled before cooking. When the potatoes are peeled before cooking, the least loss is sustained by putting them directly into hot water and boiling as rapidly as possible. Even then the loss is very considerable. If potatoes are peeled and soaked in cold water before boiling, the loss of nutrients is very great, being one-fourth of all the albuminoid matter.

Experiments were made with carrots under much the same condition as those with potatoes. These were taken as likely to show the possibility of loss during the cooking of roots, such as beets, parsnips, etc. The carrots used in the experiments were cut in wedge-shaped pieces, averaging about 4 inches in length. Some pieces were cut larger and some smaller. The loss was greatest with the small pieces, amounting to 30 per cent of the total food material, or, more specifically, to 42 per cent of the nitrogenous matter, 26 per cent of the sugar, and 47 per cent of the mineral constituents. It seems to make comparatively little

difference whether the water used was hard or soft, or if it were hot or cold at the start. The medium-sized pieces lost the same amount of sugar as the small pieces, but less nitrogen and less mineral matter. As was to be expected, the least loss occurred when large-sized pieces were used, but even then it amounted to one-fifth of the total nutrients, one-fifth of the nitrogenous matter, one-sixth of the sugar, and over one-fourth of the mineral constituents. When it is considered that carrots really contain as much water as is found in milk, it is readily seen that with the loss of from one-fifth to one-third of the whole nutritive matter there is no great food value left in the cooked carrots. The loss of sugar during the boiling of carrots is equivalent to nearly 1 pound of sugar in a bushel of carrots.

It appears, therefore, that in order to retain the greatest amount of nutrients in the cooking of carrots (1) the pieces should be large rather than small; (2) the boiling should be rapid, in order to give less time for the solvent action of the water to act upon the food ingredients; (3) as little water as possible should be used; and (4) if the matter extracted be used as food along with the carrots, instead of being thrown away, the loss of 20 to 30 per cent, or even more, of the total food value may be prevented.

Taking cabbage as a type of pot herbs in which the leafy portion is the part eaten, experiments similar to those with potatoes and carrots were made. From the result of these tests it appears that the kind of water (hard or soft) has more effect on the loss of nutrients than the temperature of the water when the cabbage is placed therein. In any case the loss of nutrients was found to be very great, amounting to one-third the total nutrients when "soft" water was used and two fifths when the water was "hard." The loss of the more valuable albuminoids was comparatively small, although the total loss of nitrogenous matter ranged from 32 to 46 per cent of the total. More than half the mineral salts were removed, and from 28 to 42 per cent of the carbohydrates.

In a cabbage weighing 3 pounds there are but 4 ounces of dry matter; the remaining 2¾ pounds is water. Of this 4 ounces, from 1¼ to 1¾ ounces may be lost during the cooking, leaving as much nutriment available from a 3-pound cabbage as would be contained in about two heaping tablespoonfuls of sugar. This loss seems to be unavoidable unless the cabbage is cooked in such a manner that the water in which it is boiled is also used. This is frequently the case when it is cooked with corned beef.

The losses which occur in cooking potatoes, carrots, and cabbage vary with the different methods of boiling followed, being quite considerable in some cases. These losses must be taken into account in computing dietaries, and made good by adding other materials to supply the nutrients lost. While the loss is not so great as to render it imperative that people in comfortable circumstances should abandon methods of preparing these foods which they consider make them most palatable, there are very large numbers who can not afford to

permit even the comparatively small waste of food observed in these experiments.

The purpose of such investigations as those described above is to learn what actually takes place in the process of preparing food by the common methods. Those having charge of the preparation of food must determine how far it is desirable under individual circumstances to apply the information obtained.

SPECIAL AND CONDIMENTAL FEEDING STUFFS.

From time to time various special and "condimental" feeding stuffs are extensively advertised for use in feeding animals. Extravagant claims are usually made for these as to their effect upon the general health of animals, and their general nutritive properties, or their special ability to increase milk production. Many of them are claimed to have tonic or medicinal properties. They frequently contain large quantities of salt, as is shown by the high percentage of ash, and sometimes a small quantity of fenugreek, or other substances of doubtful medicinal value. Within the past few years several experiment stations have examined a number of these materials The average results of the analyses of these, together with the selling price, where given, and the composition of some common feeding stuffs, are summarized in the following table:

Composition of some special and condimental feeding stuffs, compared with that of standard articles.

	Water.	Ash.	Protein.	Fat.	Fiber.	Nitrogen-free extract.	Remarks.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Pratt's Cattle Food	10.77	6.27	14.42	6.92	5.37	56.25	Cost, $0 per 100 pounds.
Weston's Condition Powders	10.80	8.08	15.53	5.40	3.33	56.79	Cost, 50 cents per package, 3 lbs.
Climax Feed	9.26	18.09	12.74	3.23	5.60	53.08	Cost, $8 per 100.
Paine's Stock Feed	11.25	10.07	11.25	10.34	10.00	47.00	Cost, $23 per ton.
Nutrietene	7.88	19.78	20.03	6.56	0.08	38.77	Average of 4 samples. Cost, $12.50 to $25 per 100 pounds.
T. B. Milk Producer	9.88	3.50	27.26	0.05	5.06	48.25	Cost, $23 per ton.
Economic Feed VI	10.70	4.75	22.81	5.90	6.90	48.04	Cost, $25 per ton.
Koji Feed	8.00	6.61	10.01	4.22	16.27	45.89	Cost, $16 per ton.
Proteina	8.57	2.35	23.10	7.07	9.68	48.24	Average of 5 samples. Cost, $24 to $25 per ton.
Special Cow Feed	10.68	1.80	13.56	6.10	6.77	61.03	Cost, $24 per ton.
Pratt's Food for Horses and Cattle.	10.80	4.22	10.90	5.83	4.90	57.26	
U. S. Milling Co.'s Special Mill Feed.	8.00	3.03	14.94	6.05	4.27	63.71	Cost, $21 per ton.
Blatchford's Calf Meal	8.10	4.30	25.60	4.50	4.60	52.00	
Cattle Feed	0.24	3.78	12.12	3.62	7.80	63.44	Cost, $17.40 per ton.
Hall's Dairy Ration	9.35	8.50	19.40	10.48	7.90	44.42	Cost, $22 per ton.
Imperial Feed	9.54	4.58	16.80	4.51	6.20	58.28	Average of 2 samples.
Thoricy Feed	8.80	11.14	20.34	7.80	4.54	47.38	
Blatchford's Feeding Powder	[1] 10.00	6.12	26.04	6.23	8.64	42.07	
Cleveland Concentrated Meal	10.60	4.40	25.51	6.32	6.83	46.28	Cost, $28 per ton.
Cleveland Standard Dairy Feed	10.88	5.56	20.47	5.37	8.77	42.95	Do.
Excelsior Feed	7.08	4.12	9.06	5.04	13.61	01.09	
Hall's Dairy Feed	7.20	6.10	20.80	9.50	10.20	40.20	
Wheat bran	11.19	5.80	15.40	4.00	9.00	53.90	
Cotton-seed meal	8.20	7.20	42.30	13.10	5.60	23.60	
Linseed meal (new process)	10.10	5.80	33.20	3.00	9.50	38.40	
Buckwheat middlings	13.20	4.80	29.90	7.10	4.10	41.90	
Soja beans	10.80	4.70	34.00	10.90	4.80	28.80	
Cowpeas	14.80	3.20	20.80	1.40	4.10	55.70	
Clover hay	15.30	0.20	12.30	3.30	24.80	38.10	

[1] Assumed; analysis in original given on the dry-matter basis.

This table shows that as far as actual nutritive ingredients are concerned the special and condimental foods have no advantage over the standard feeding stuffs found in the market, and that in many cases the price is far in excess of that of standard articles furnishing an equivalent or greater amount of actual nutriment.

As already stated, however, it is claimed for some of the foods that, in addition to their medicinal properties, they have a special power of stimulating the production of meat and milk. If this claim were true it would not be fair to compare them on the basis of cost per ton and actual content of nutritive ingredients with ordinary feeding stuffs, since they are not intended to entirely replace the usual grain ration, but are to be mixed with it in small amounts. The claims regarding special medicinal and stimulating properties have been investigated to some extent by the experiment stations.

About three years ago the Vermont Experiment Station made a feeding trial with Nutriotone. This material was at that time, and has been since, quite extensively advertised in certain sections, the claim being made that aside from its tonic properties it is a stimulant to the production of flesh and milk. The circular of the makers states that if two tablespoonfuls are mixed with each grain feed "the user will be agreeably surprised at the increased quantity and improved quality of milk * * * and productiveness of the animals." In the Vermont experiments these directions were followed, but according to the results given there was no apparent benefit from feeding Nutriotone, either in yield of milk or fat.

Recently the Maine Experiment Station has made a similar trial of the merits of Nutriotone, using 5 Jersey cows fresh in milk. The total yield of milk when Nutriotone was fed was 2,264 pounds, and when no Nutriotone was fed the yield was 2,281 pounds. There was no difference between the amount of butter fat produced when Nutriotone was fed and when it was omitted from the ration, 100 pounds being produced in both instances. The statement is made that the money spent for the Nutriotone in this case was a dead loss.

No tests have been made of the tonic or medicinal properties of Nutriotone. Sir John B. Lawes, of the experiment station at Rothamsted, England, many years ago showed condimental cattle foods to be of no advantage to healthy stock. It is believed to be ill advised to administer medicine to healthy animals. If a tonic is needed a preparation of known composition can be provided at far less cost than in the form of condimental foods.

It is very doubtful whether there is any advantage to the farmer in buying specially mixed or prepared feeds, whether they are supposed to possess condimental properties or not. In the long run, it is believed to be better and more economical for the feeder to buy the materials which he needs and mix them to suit his purpose.

STEER AND HEIFER BEEF.

Widely different opinions are held as to the comparative value of steer and heifer beef. American packers rate steers at from 25 to 50 cents per hundred more than heifers of the same age, breed, and general qualities. On the other hand, the opinion in England is the reverse, heifer beef being rated higher than steer beef.

For some years feeding experiments have been made at the Iowa Station to study the comparative value of steers and heifers for fattening. In the first trial one lot of steers, one lot of spayed heifers, and one lot of open heifers were used. They were all grade Shorthorns, as nearly alike in breeding and development as possible. There were five animals in each lot. The lots were fed and treated in the same manner. Seven of the heifers calved during the trial, which interfered with the comparison. The steers made a larger gain and sold for 1 cent per pound, live weight, more than the heifers. During the whole test, which lasted about eleven months, the steers made an average gain of 806 pounds; one open heifer, clear of calf, gained 775 pounds; four open heifers that had calves made an average gain of 628 pounds; two spayed heifers, clear of calf, made an average gain of 736 pounds; and three spayed heifers that had calves averaged 645 pounds gain.

The steers were sold at 5.75 cents and the heifers at 4.75 cents per pound, live weight. Allowing 3.5 cents per pound for the steers and 2 cents for the heifers at the beginning of the trial, there was a profit of $64.39 on the steers, $30.51 on the unspayed heifers, and $13.76 on the spayed heifers. The average proportion of beef in the carcass was 63.2 per cent for the steers, 62.4 for the unspayed heifers, and 62.8 for the spayed heifers.

When slaughtered, the carcasses were cut and judged by an expert. The heifers gave a larger percentage of prime cuts (ribs and loins) than the steers, so that, on the basis of the meat and by-products obtained and the price paid for the steers, the heifers were worth from 0.57 to 0.62 cent a pound more than was paid for them.

Crediting each lot with the actual value of the different cuts and the by-products, and not including the expense of killing and handling, it is calculated that, at the prices which the butcher paid, he made $20.45 on the steers, $58.12 on the unspayed heifers, and $64.84 on the spayed heifers. In other words, the returns made by the heifers would have justified a purchase price of $5.37 per hundred for the spayed heifers and $5.32 for the open heifers, instead of $4.75 for each, and still have left the same profit as with the steers.

The results of a second trial to compare steers and heifers for beef production have been recently published. The test was made with 15 pure-bred or high-grade Herefords. The animals were divided into three equal lots, one of steers, one of spayed heifers, and one of open heifers, and all were fed alike during fourteen months.

The results of the experiment are briefly summarized in the following table:

Results of feeding steers and heifers for beef.

	Average weight at end of test.	Average daily gain per head.	Dry matter eaten per pound of gain.	Average cost of feed per pound of gain.
	Pounds.	*Pounds.*	*Pounds.*	*Cents.*
Steers	1,388	1.71	8.70	4.08
Open heifers	1,300	1.86	7.67	3.65
Spayed heifers	1,337	1.70	8.60	4.05

As shown by the experiment, the heifers made a slightly greater average gain from correspondingly less food and at a less cost than the steers. Carefully conducted slaughter and block tests did not reveal any material difference in the character, composition, or quality of meat from steers and heifers, although the percentage of high-priced cuts, ribs, and loins was greater in both lots of heifers than in the case of the steers.

It has been claimed that the principal cuts in heifer carcasses contain more fat than those of steers, and are therefore less profitable to the consumer. The average cost of the beef to the firm purchasing the cattle raised in these experiments was 6.51 cents for the steers, 6.21 cents for the spayed heifers, and 6.14 cents for the open heifers. The average selling price received by them was 6.59 cents, 6.26 cents, and 6.24 cents, respectively.

It was observed in this and other investigations, that under similar conditions heifers are inclined to take on flesh a little more readily than steers. Larger gains by the heifers may not be shown, but there is a tendency to finish at a little earlier stage in the process of fattening. The difference between steers and heifers in this regard, when fed under the same conditions has also been noted by practical stockmen, feeding on an extensive scale.

The fact is emphasized that heifer beef has been much underestimated, since in both trials the heifers have returned a higher net profit on the block than the steers, notwithstanding the fact that the steer beef was rated higher than the heifer beef. So far as could be learned from these experiments, spaying had no particular influence on the gains made.

THE CAUSE AND PREVENTION OF "SWELLS" IN CANNED VEGETABLES.

When vegetables are canned a greater or smaller percentage of the total number of cans often undergo fermentation and are spoiled. The fermentation is shown by the cans bulging, owing to the gas produced inside the can. The spoiled cans are technically known as "swells," and are entirely worthless. The Wisconsin station investigated the cause of this trouble, which had been very common at a factory for

canning peas. The percentage of swells was often so large as to cause serious financial loss. Examination of the spoiled cans revealed the presence of two kinds of bacteria, one of which proved to be an organism capable of fermenting sugar solutions, with the production of considerable quantities of gas.

The various steps in canning peas are shelling, grading, blanching by immersing in boiling water for one or two minutes, placing in the cans, filling the cans with a solution of salt to which sugar is added when the peas are deficient in this constituent, hermetically sealing the cans, and cooking in tightly closed steam cookers. Immersing the peas for one or two minutes in boiling water to blanch them would not be sufficient to destroy the bacteria, but it was supposed that the final heating under pressure would do this. It was not thought desirable to heat the cans for a longer time than was ordinarily done, because this would cause the peas to split and render the liquid in the cans turbid. Experiments were, however, undertaken in which the cans were heated for the usual time under greater pressure—that is, at a higher temperature. This treatment was found to be very satisfactory. The peas did not split and very few cans spoiled.

The results of experiments following the usual process and the experimental process described are shown in the following table:

Details of canning peas.

	Steam pressure in cooking.	Temperature.	Time.	Number of cans "processed."	"Swells."	
					Total number.	Per cent.
Peas rich in sugar:	*Pounds.*	*Degs. F.*	*Minutes.*			
Usual process	10	232	26	6,175	300	5.0
Experimental process	15	242	28	11,859	8	(1)
Peas deficient in sugar:						
Usual process	11	234	17	4,007	135	[2]3.0
Experimental process	15	242	30	2,520	14	[2]0.5

[1] Practically none. [2] About.

In view of the fact that home canning of vegetables and fruits is often recommended for farmers, these experiments are of especial interest. The heating under unusual pressure—that is, at a high temperature—was very successful as a preventive of swells, and did not injure the quality of the product. In canning operations on a large or small scale it is desirable to heat the cans under such pressure that the bacteria causing decomposition may be entirely destroyed, and at the same time care must be taken not to heat the cans for so long a time that the appearance or taste of the contents is injured.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all foods and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain, to 80 pounds in silage and 90 pounds in some roots.

Dry matter is the portion remaining after removing or excluding the water.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorin, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc., and is one of the most important constituents of feeding stuffs.

Albuminoids is the name given to one of the most important groups of substances classed together under the general term protein. The albumen of eggs is a type of the albuminoids.

Carbohydrates.—The nitrogen-free extract and fiber are usually classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, besides real fats, wax, the green coloring matter of plants, etc. The fat of food is either stored up in the body as fat or burned, to furnish heat and energy.

MISCELLANEOUS TERMS.

Tuber is the term applied to the enlarged underground portion of a plant, which, as in the case of the potato, is not a true root, but an enlarged underground stem.

Humus is the name applied to the partially decomposed organic (animal and vegetable) matter of the soil. It is the principal source of nitrogen in the soil.

Nitrogen is the most expensive of the three essential fertilizing ingredients (the other two being potash and phosphoric acid), and exists in soils and fertilizers in three distinct forms, viz, as organic matter, as ammonia, and as nitrate.

Nitrates are the most readily available forms of nitrogen. The most common forms are nitrate of soda and nitrate of potash (saltpeter).

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag.

Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble phosphoric acid.

Superphosphate.—In natural or untreated phosphates the phosphoric acid is insoluble in water and not readily available to plants. Superphosphate is prepared from these by grinding and treating with sulphuric acid, which makes the phosphoric acid more available to plants. Superphosphates are sometimes called acid phosphates.

Ammoniated superphosphate is the trade name for a mixture of a superphosphate with some material supplying nitrogen.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water, and are believed to be nearly if not quite equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvanite, muriate of potash, sulphate of potash, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash. The potash in them is in the form of carbonate.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

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No. 16. Leguminous Plants for Green Manuring and for Feeding. Pp. 24.

No. 18. Forage Plants for the South. Pp. 30.

No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.

No. 21. Barnyard Manure. Pp. 32.

No. 22. Feeding Farm Animals. Pp. 32.

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No. 61. Asparagus Culture. Pp. 40.

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